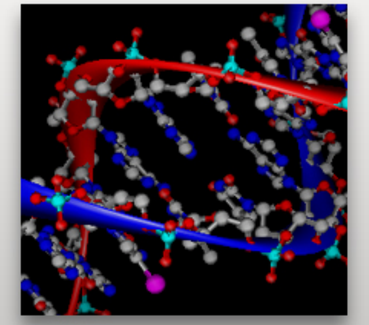
FireWire

Session 504

These are confidential sessions—please refrain from filming or taking pictures.

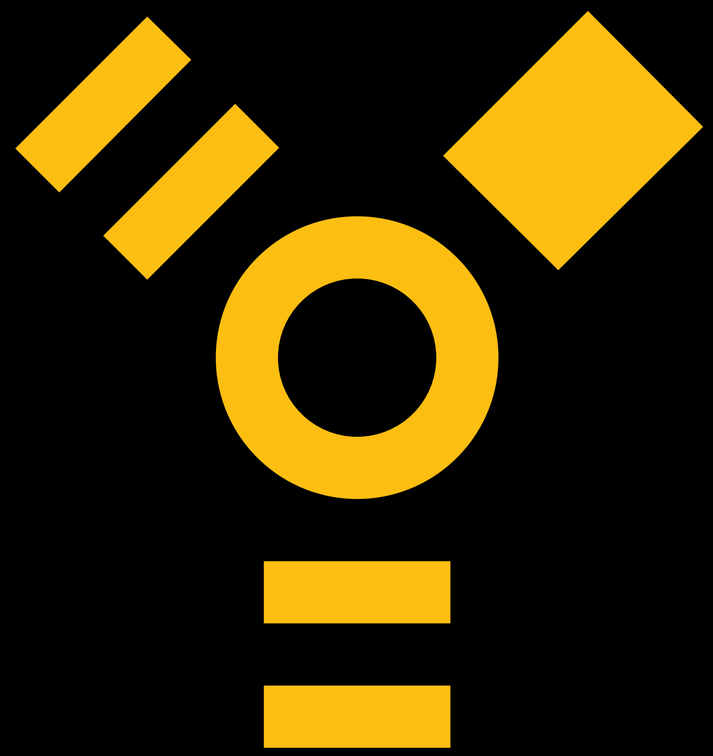


OS Foundations

FireWire

Eric Anderson
Manager, FireWire Software

http://developer.apple.com/wwdc2005/



Outline

- FireWire Basics
- Bringup and Hardware Debug
- Software Debug
- Resources

Want to Follow Along?

- FireWire SDK 20
  - http://developer.apple.com/sdk
- The installer puts files in /Developer/FireWireSDK20
  - Does not change your system software
  - No reboot required
- No FireWire device needed today
  - iSight, iPod, etc. may be useful
- Save work before using FireWire tools

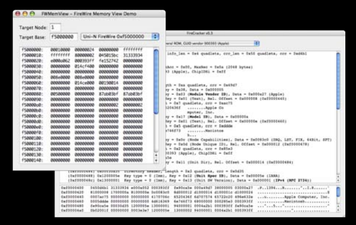
FireWire Basics

http://developer.apple.com/wwdc2005/

FireWire Strengths

- More power (6 to 15 Watts)
- More speed (800 megabits per second)
- More distance (100 meters)
- More devices (63 per bus)
- Lots of software and tools

FireWire in Mac OS X



SBP-2

AV/C

IIDC

IP

IOFireWireFamily

Hardware

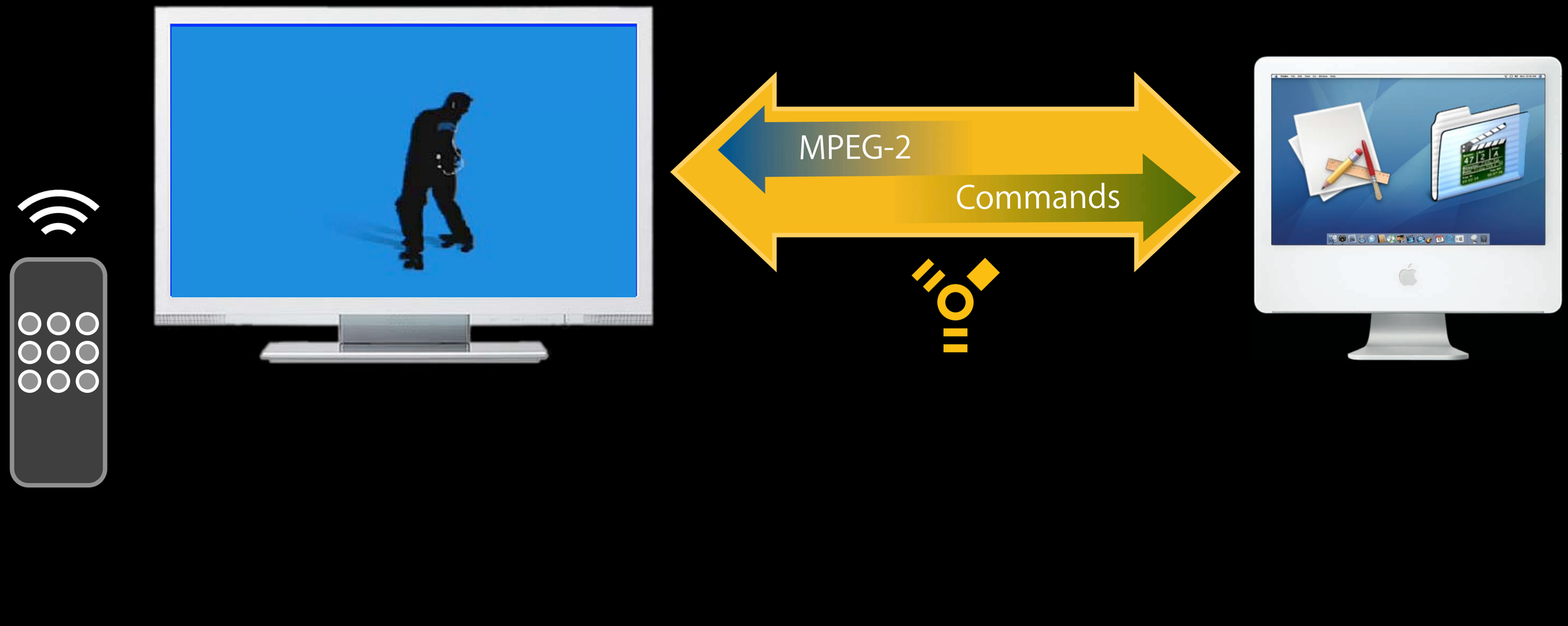
AVS—AV/C Video Services

- Feature-rich framework for streaming applications
- Application-level services for
  - MPEG and DV streaming, including HDV and DVCProHD
  - AV/C device discovery, control, and connections
  - Virtual devices
- Used by iMovie, Final Cut Express/Pro, iDVD
  - But, consider QuickTime APIs too
- Available in SDK 20 as sample code

AVS

Virtual devices

- Many HDTVs will control a FireWire DVHS or AV-HDD
  …or a Mac that poses as such a device



AVS

Virtual Tape Subunit and MPEG

- New—Mac emulates an AV/C Tape Subunit
  - Publishes AV/C Config ROM
  - Responds to SUBUNIT_INFO request
  - Accepts PLAY, RECORD, PAUSE, STOP, etc.
  - Generic—not specific to any tape or AV format

- New—Virtual MPEG Tape Player / Recorder
  - Uses generic Virtual AV/C Tape Subunit
  - Uses AVS for MPEG transmit and receive
  - Demonstrates “trick play” for fast forward / reverse

AVS

Virtual Music Subunit

- New—Mac emulates an AV/C Music Subunit
  - Publishes AV/C Config ROM
  - Responds to SUBUNIT_INFO request
  - Accepts connection routing inquiries and commands
  - Works with Apple FireWire Audio for streaming
    - Bidirectional, multi-channel, audio and MIDI

FireWire Bringup and Hardware Debug

http://developer.apple.com/wwdc2005/

FireBug

- Packet-level “snooper” (like EtherPeek)
- Formats all FireWire packets
- Filters and triggers
- Decodes SBP-2, AV/C, IP-1394 (RFC 2734)
- Displays bus topology
- Displays PHY registers
- Basic bus configuration and debug
- Real-time

FireBug Demo

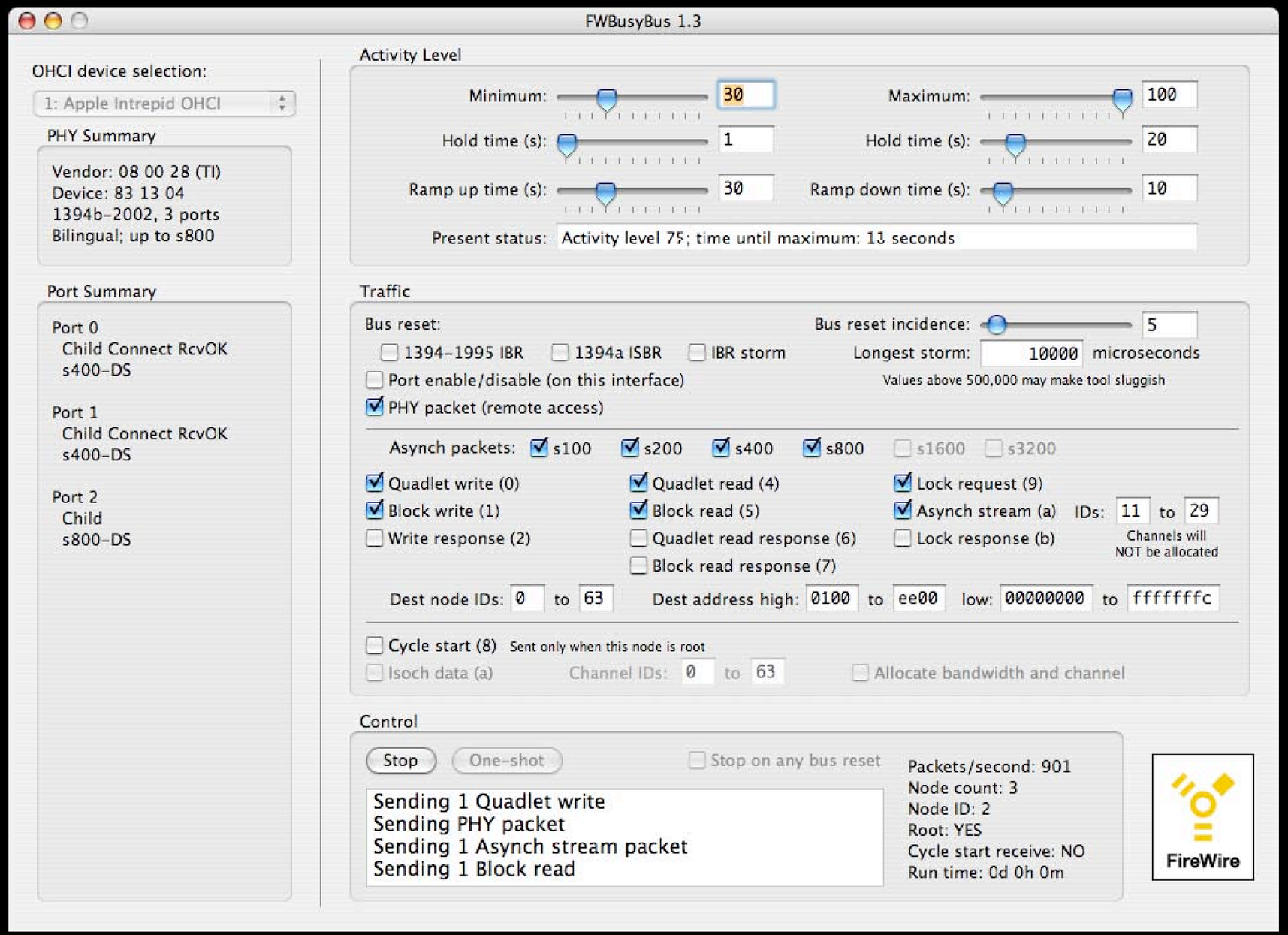
FireBug 2.3 05.04.01 Copyright 1997-2004, Apple Computer Inc.

```
CycleTimer: 060:4095:0871    NodeID: 00   Root: 0   CPS: 0   Packets:  1041/007884455  Lost: 000000000
 tCode  sec  total |  tCode  sec  total |    PHY  sec  total |    ACK  sec  total |  rCode  sec  total
wrQuad  168 012836 | cycSt     0 +28863 | Config    0 001741 | (none)  944 054837 | complt    0 000273
wrBloc  141 007910 | lockRq  223 013188 | LinkOn    0 000000 | complt    0 000282 | cnflct    0 000000
wrResp    0 000009 | isoch    97 398364 | SelfID    0 000207 | pendng    0 000273 | datErr    0 000000
(3rsv)    0 000000 | lkResp    0 000012 |____________________| busy_X    0 000000 | typErr    0 000000
rdQuad  273 013760 | (Crsv)    0 000000 | s100    327 +41807 | busy_A    0 000000 | addErr    0 000000
rdBloc  139 007508 | (Drsv)    0 000000 | s200    349 020720 | busy_B    0 000000 |__________________
rdQRes    0 000252 | (Ersv)    0 000000 | s400    365 022257 | datErr    0 000000 | badCRC    0 000000
rdBRes    0 000000 | (Frsv)    0 000000 | RESET     0 000048 | typErr    0 000000 | badDMA    0 000000

084:0320:1508  Bwrite fr ffc3 to ffc1.ffff.f000.0b00, sz 8 [actl 8], tLab 23 [ack 1] s100
               0000   01ff3107 ffffffff                      ..1.....
    FCP Request: 0x1 (STATUS);  su_type 0x1f (unit);  su_ID 7 (n/a);  opcode 0x31
      AVC/UNIT:  SUBUNIT INFO
084:0331:3021  Bwrite fr ffc1 to ffc3.ffff.f000.0d00, sz 8 [actl 8], tLab 23 [ack 2] s100
               0000   0cff3107 2038ffff                      ..1. 8..
    FCP Response: 0xc (IMPLEMENTED/STABLE);  su_type 0x1f (unit);  su_ID 7 (n/a);  opcode 0x31
      AVC/UNIT:  SUBUNIT INFO
093:0836:2415  PHY Access to node 0, page 0, port 0, reg 7 [00040700]
093:0836:2785  PHY Reply from node 0, page 0, port 0, reg 7, data 00 [000c0700]
093:1139:0840  LockRq from ffc1 to ffc3.ffff.f000.0220, size 8, tLabel 0 [ack 2] s100
               0000   00001388 000009d8                      ........
    IRM: Allocate 0x9b0 (2480) BANDWIDTH units
093:1139:1208  LockResp from ffc3 to ffc1, size 4, tLabel 0 [ack 1] s100
               0000   00001388                               ....
    IRM: Change was accepted
  Isoch channel 63 ACTIVE at 093:1239:1719 (CT 091:6701), speed s100
     Format is DV (NTSC), source node ID is 0x01
093:1239:1719  Isoch channel 63, tag 1, sy 0, size 8 [actual 8] s100
               0000   01780000 8000ffff                      .x......
093:2200:1051  Isoch channel 31, tag 3, sy 0, size 74 [actual 76] s400
               0000   ffc30000 5e000001 00000800 4518003e    ....^.......E..>
    GASP 2734: etherType IPv4 (from ffc3)
    IPv4 from 169.254.240.255 to 224.0.0.251
099:6632:2415  Qread from ffc2 to ffc1.ffff.f000.0400, tLabel 44 [no ack] s100
101:3813:2000  PHY Config, force_root = 03, gap_count = 07
101:3815:0629  BUS RESET ------------------------------------------------------------------------
101:3815:0629  Self-ID  80078494  Node=0  Link=0  gap=7  spd=s400  C=0  pwr=4: use <3W
101:3815:0993  Self-ID  810784d5  Node=1  Link=0  gap=7  spd=s400  C=0  pwr=4: use <3W

> src on 5-8 12
Source Node ID filter will only match packets with these src IDs:
  0, 2, 5-8, 12
```

FWBusyBus

- Packet Generator
  - Creates random traffic
  - Adjustable; can be very selective
- No special hardware needed
  - Works on all modern Mac systems
- Stress-test your device

FWBusyBus Demo



FireCracker

- Configuration ROM viewer
  - No skeleton key
  - No hardware needed
  - Completely safe
- Very helpful for driver matching work
  - Please test your config ROMs even if matching seems OK

FireCracker Demo

FireCracker v0.3

Show Config ROM from: FireWire bus | Node 0: General ROM, GUID vendor 000393 (Apple)

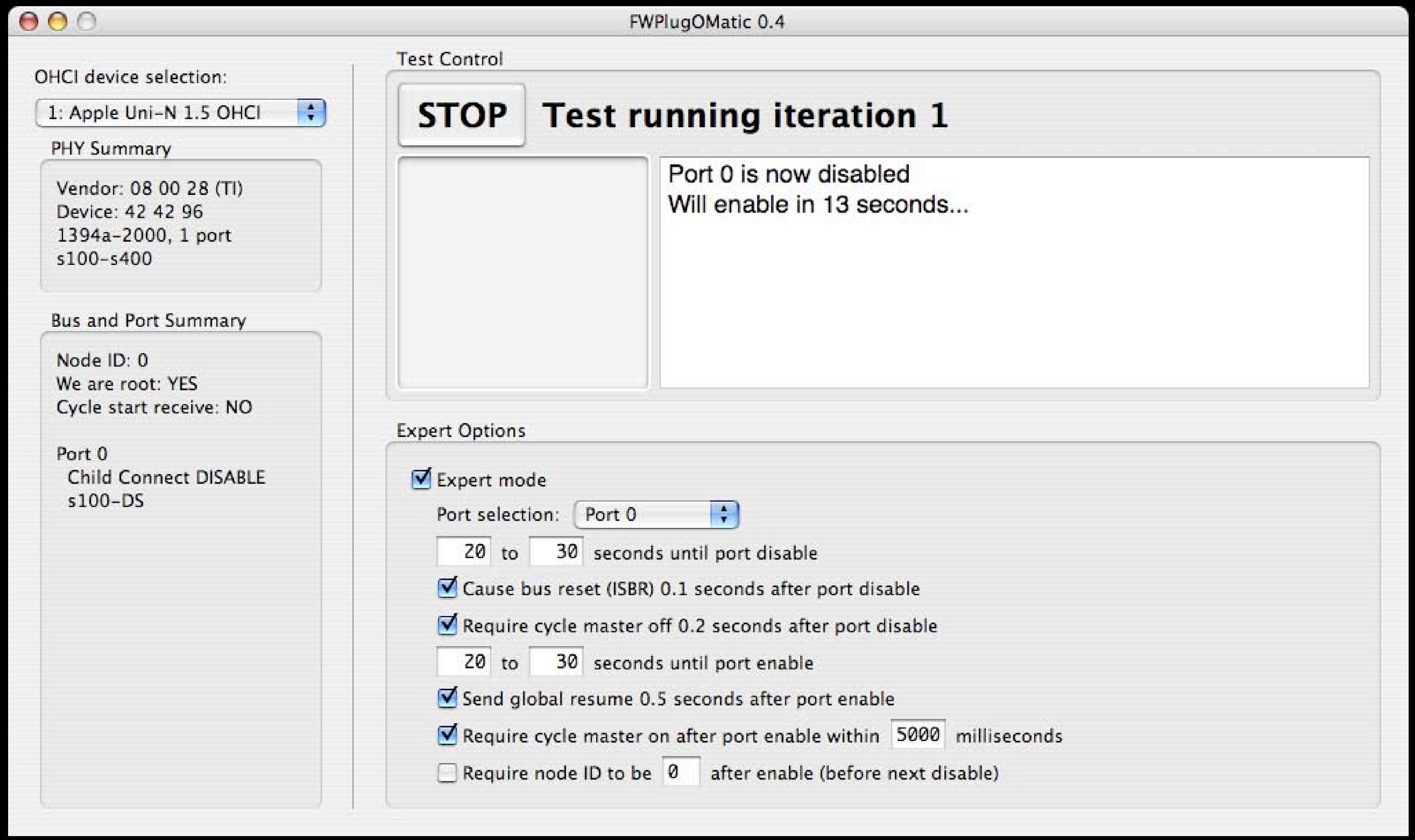
```
(0xf0000400) 0x0450d4b1  ROM Header (General), info_len = 0x4 quadlets, crc_len = 0x50 quadlets, crc = 0xd4b1
Bus Information Block:
(0xf0000404) 0x31333934  "1394"
(0xf0000408) 0xe000a052  IRMC, CMC, ISC, CycClkAcc = 0x00, MaxRec = 0x0a (2048 bytes)
(0xf000040c) 0x000393ff  NodeVendorID = 0x000393 (Apple), ChipIDHi = 0xff
(0xf0000410) 0xfe90ca5e  ChipIDLo = 0xfe90ca5e
Root Directory:
(0xf0000414) 0x000a49d7  Directory header, length = 0xa quadlets, crc = 0x49d7
(0xf0000418) 0x38000005  Key type = 0 (Imm), Key = 0x38, Data = 0x000005
(0xf000041c) 0x03000a27  Key type = 0 (Imm), Key = 0x03 (Module Vendor ID), Data = 0x000a27 (Apple)
(0xf0000420) 0x81000008  Key type = 2 (Leaf), Key = 0x01 (Text), Rel. Offset = 0x000008 (0xf0000440)
   (0xf0000440) 0x0007ac75  Leaf header, length = 0x7 quadlets, crc = 0xac75
   (0xf0000444)   00000000 00000000 4170706c 6520436f   ........Apple Co
   (0xf0000454)   6d707574 65722c20 496e632e            mputer, Inc.
(0xf0000424) 0x1700000a  Key type = 0 (Imm), Key = 0x17 (Model ID), Data = 0x00000a
(0xf0000428) 0x8100000e  Key type = 2 (Leaf), Key = 0x01 (Text), Rel. Offset = 0x00000e (0xf0000460)
   (0xf0000460) 0x0005ddde  Leaf header, length = 0x5 quadlets, crc = 0xddde
   (0xf0000464)   00000000 00000000 4d616369 6e746f73   ........Macintos
   (0xf0000474)   68000000                              h...
(0xf000042c) 0x0c0083c0  Key type = 0 (Imm), Key = 0x0c (Node Capabilities), Data = 0x0083c0 (DRQ, LST, FIX, 64Bit, SPT)
(0xf0000430) 0x8d000012  Key type = 2 (Leaf), Key = 0x0d (Node Unique ID), Rel. Offset = 0x000012 (0xf0000478)
   (0xf0000478) 0x000285e3  Leaf header, length = 0x2 quadlets, crc = 0x85e3
   (0xf000047c) 0x000393ff  NodeVendorID = 0x000393 (Apple), ChipIDHi = 0xff
   (0xf0000480) 0xfe90ca5e  ChipIDLo = 0xfe90ca5e
(0xf0000434) 0xd1000014  Key type = 3 (Dir), Key = 0x11 (Unit Dir), Rel. Offset = 0x000014 (0xf0000484)
   Unit Directory:
   (0xf0000484) 0x00030d35  Directory header, length = 0x3 quadlets, crc = 0x0d35
   (0xf0000488) 0x1200005e  Key type = 0 (Imm), Key = 0x12 (Unit Spec ID), Data = 0x00005e (IANA)
   (0xf000048c) 0x13000001  Key type = 0 (Imm), Key = 0x13 (Unit SW Version), Data = 0x000001 (IPv4 (RFC 2734))
```

```
0xf0000400   0450d4b1 31333934 e000a052 000393ff  fe90ca5e 000a49d7 38000005 03000a27  .P..1394...R.......^..I.8......'
0xf0000420   81000008 1700000a 8100000e 0c0083c0  8d000012 d1000014 d100001c d1000024  ...............................$
0xf0000440   0007ac75 00000000 00000000 4170706c  6520436f 6d707574 65722c20 496e632e  ...u........Apple Computer, Inc.
0xf0000460   0005ddde 00000000 00000000 4d616369  6e746f73 68000000 000285e3 000393ff  ............Macintosh...........
0xf0000480   fe90ca5e 00030d35 1200005e 13000001  94000001 0004a2b1 000393ff fe90ca5e  ...^...5...^...................^
0xf00004a0   0b02001f 00000000 0003e3e7 1200005e  13000002 94000001 0004a2b1 000393ff  ...............^...............
```

FWPlugOMatic

- Simulates device plug and unplug
- Simple sanity checking
- Saves wear and tear
- Does not disconnect power

FWPlugOMatic Demo

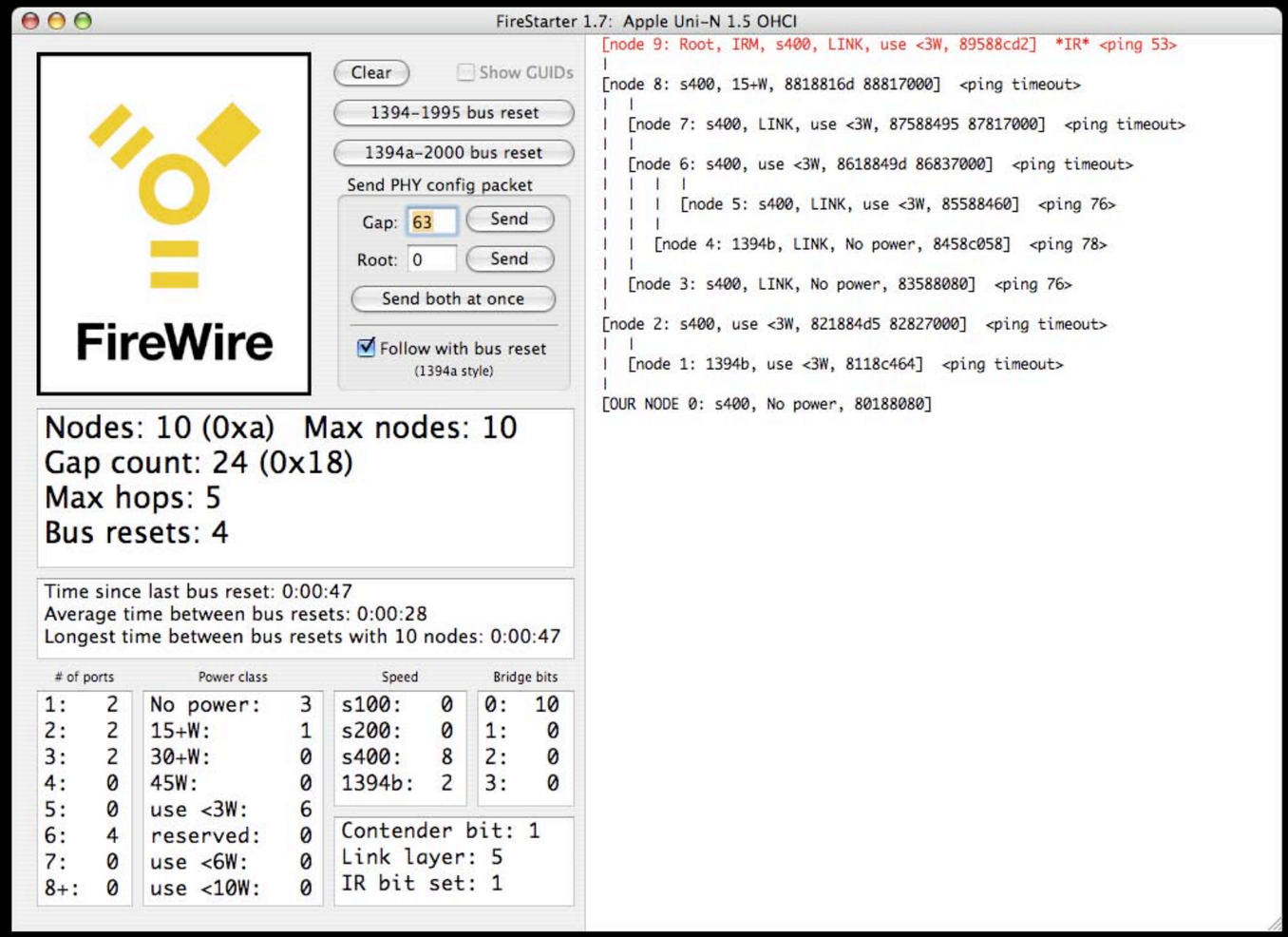


Skeleton Key Tools

- Tools touch hardware directly
  - Powerful but dangerous
  - Not suitable for customer use
- Tools unload IOFireWireFamily
  - Tool should be passive on bus
  - Use a dedicated Mac for tool(s)

FireStarter

- Basic bus topology viewer
- Same display as FireBug
  …but works with OHCI
- See at plugfest event
  Thursday at Apple



PHYTool

Digression—what is the PHY?

Host Bus (PCI)

Link

- DMA
- Host Bus Interface
- FIFOs
- Addressing
- CRC and acks
- Isochronous
- Software-driven

PLIF

PHY

- Clocking
- Serialization
- LVDS
- Arbitration
- Repeater

Port 1

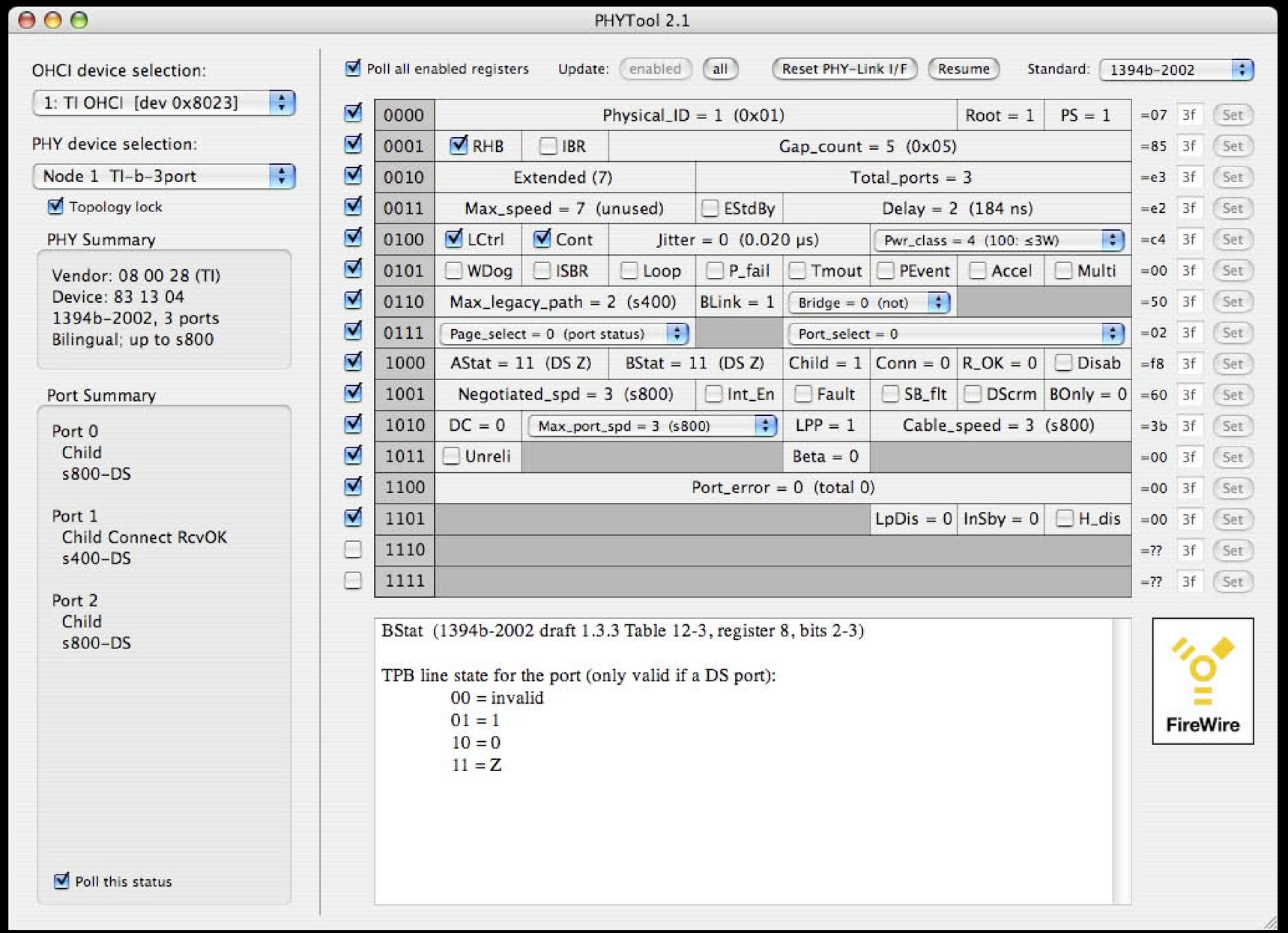
Port 2

Port 3

PHYTool

- View and edit PHY registers
- Debug FireWire port connections
- Built-in specification for reference

PHYTool Demo



FireWire Software Debug

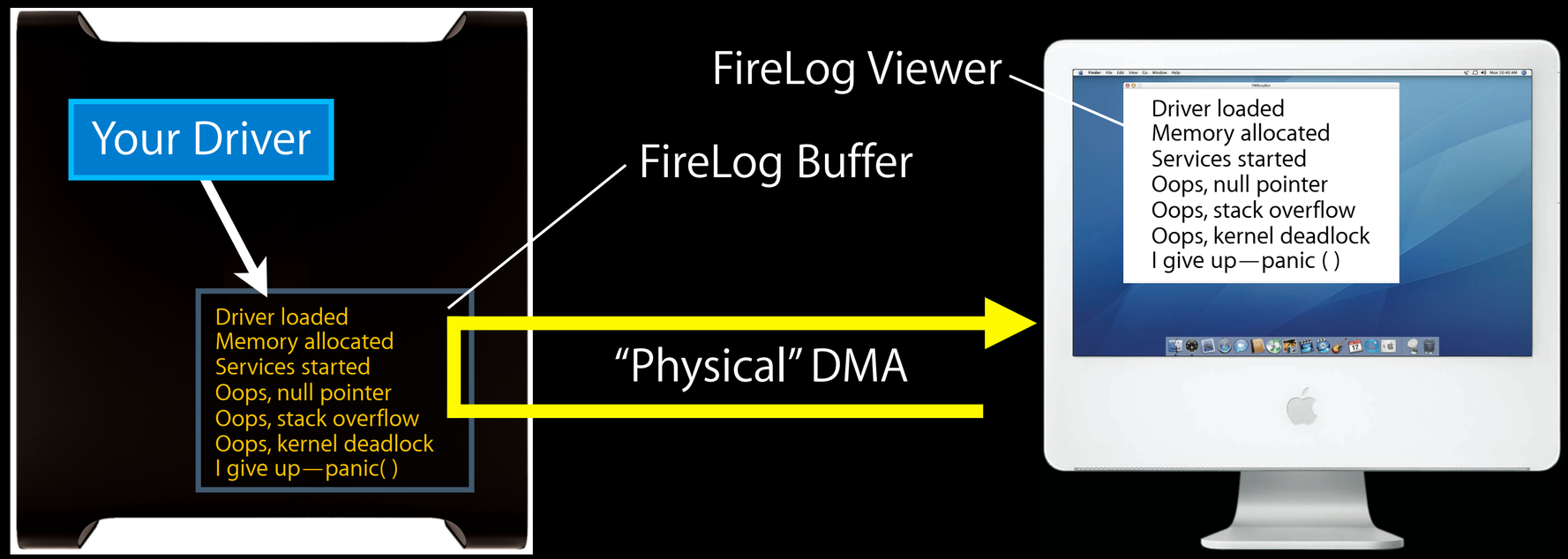
http://developer.apple.com/wwdc2005/

FireWire kprintf

- Use FireWire like a serial port
- Replaces FireWire services
  - Best for debugging anything except FireWire
- Simple, low-overhead
- Available in FireWire SDK 20

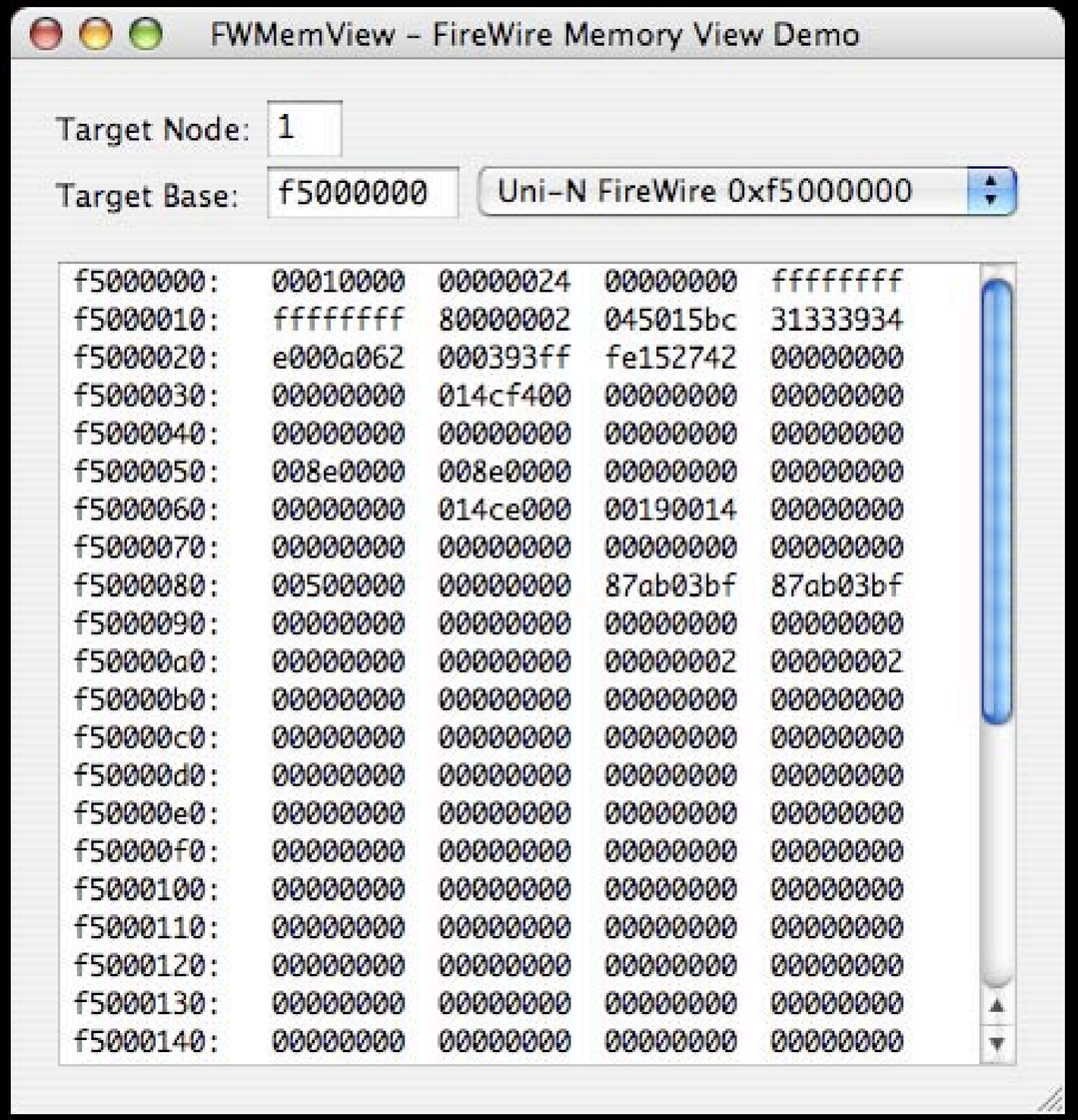
FireLog

- FireWire kprintf's "big brother"
- Also like a serial port
- Uses FireWire "Physical DMA" for even lower overhead
- Co-exists with normal FireWire services
- "Panic Proof"

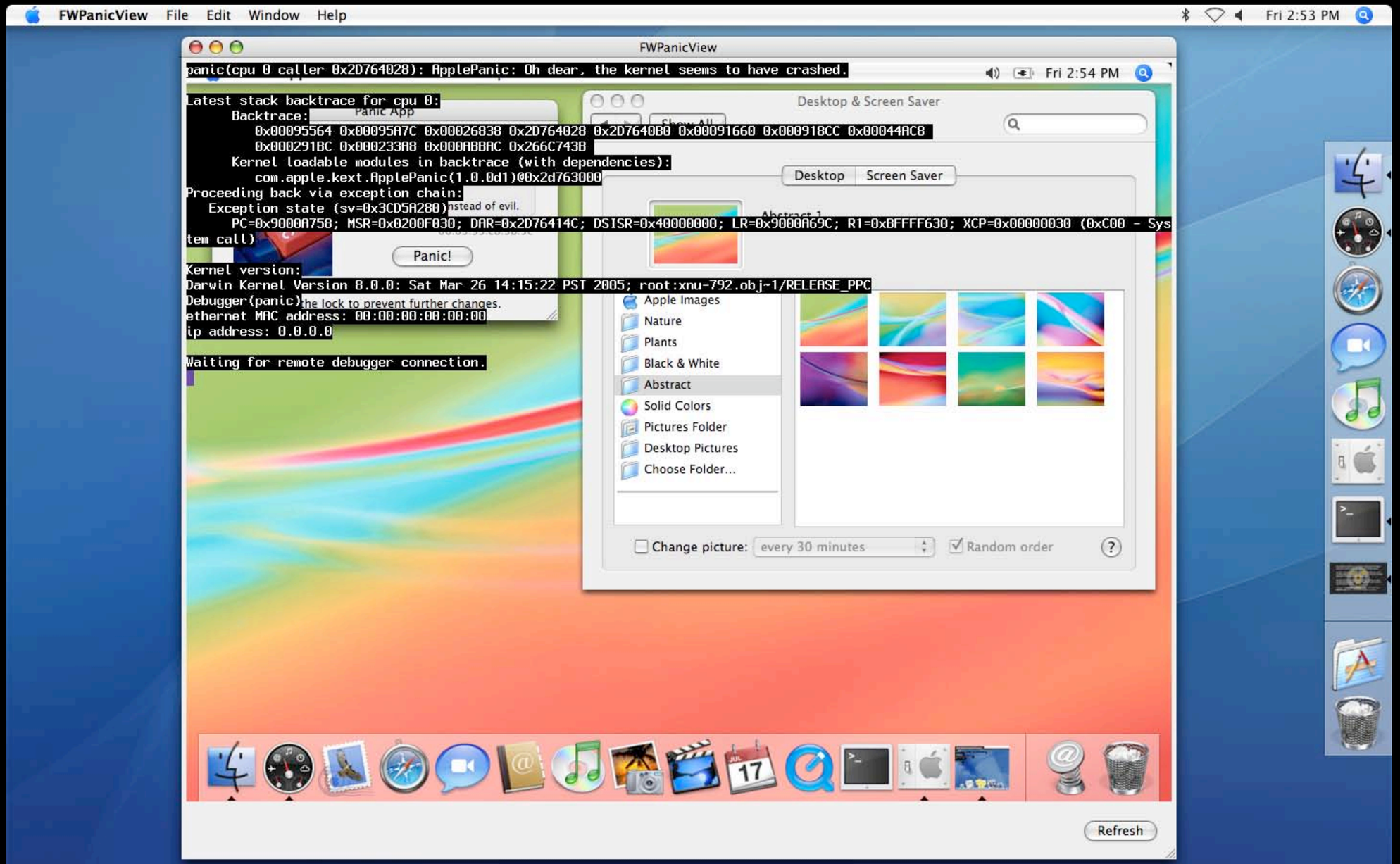


FWMemView

- Like the innards of FireLog
- Completely passive
- Examine memory in another Mac
- Safe (for the host…)



FWPanicView Demo



More Information

http://developer.apple.com/wwdc2005/

Documentation, Sample Code, and Other Resources

http://developer.apple.com/wwdc2005/

Related Sessions

Kernel Lab	Lab Thursday 2:00PM
Plugfest at Apple	Apple Campus Thursday Evening

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http://developer.apple.com/wwdc2005/

WWDC2005

Worldwide Developers Conference